

A REPORT OF THE CSIS
GLOBAL HEALTH POLICY
CENTER

The Defense Department's Enduring Contributions to Global Health

THE FUTURE OF THE U.S. ARMY AND NAVY OVERSEAS MEDICAL
RESEARCH LABORATORIES

Authors

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INTRODUCTION AND ACKNOWLEDGMENTS

In the spring of 2010, CSIS launched a year-long, independent examination of the U.S. Army and U.S. Navy overseas medical research laboratories. The impetus was an awareness that despite the laboratories' impressive scientific accomplishments and contributions to U.S. national interests and global health, they are not well understood outside of research circles, and consequently find themselves undervalued in today's environment of fiscal austerity. They stand at the intersection of health and security, a topic of increased importance to U.S. approaches to global health.

The CSIS project aimed to assess the laboratories' contributions and achievements; examine the factors that constrain their performance; and propose reforms that will put them on the best course to continued success. It included considerable background research, three formal meetings of experts, travel to five overseas laboratories, and interviews with dozens of laboratory researchers and collaborators. My coauthors and I are deeply grateful for the tremendous insight and support given to us throughout the project.

We are particularly indebted to several individuals, both within and outside of government, who repeatedly informed our work over the course of a year: Colonel Kent Kester (Commander) and Lieutenant Colonel Jamie Blow, Walter Reed Army Institute of Research (WRAIR); Captain Richard Haberberger (Commanding Officer) and Dr. Stephen Walz, Naval Medical Research Center (NMRC); Dr. Deborah Birx, Dr. Scott Dowell, and Dr. Ray Arthur, Centers for Disease Control and Prevention (CDC); Rear Admiral (retired) Thomas Cullison, Former Deputy Surgeon General of the United States Navy (USN); Dr. Wayman Wendell Cheatham, Office of the Surgeon General of the United States Navy; Captain Kevin Russell, USN, Armed Forces Health Surveillance Center/Global Emerging Infections Surveillance and Response System (AFHSC-GEIS); Colonel Julia Lynch, USA, Military Infectious Disease Research Program (MIDRP); Dr. H. Kyle Webster, Worldwide Antimalarial Resistance Network (WWARN), Oxford University; Dr. Patrick Kelley, National Academy of Sciences (NAS); Dr. Edmund Tramont, National Institute of Allergy and Infectious Diseases (NIAID); Dr. Warner Anderson and Commander Robert Donovan, USN, Office of the Assistant Secretary of Defense for Health Affairs, U.S. Department of Defense (DoD/HA); Dr. Dennis Carroll, U.S. Agency for International Development (USAID); Dr. Daniel Miller, Department of Health and Human Services (DHHS); Dr. Akhila Kosaraju, SIGA Technologies; Dr. Julie Fischer, Stimson Center; Dr. Rebecca Katz, George Washington University; Dr. Joshua Michaud, Kaiser Family Foundation (KFF) and the Johns Hopkins University Paul H. Nitze School of Advanced International Studies (SAIS); Commander Bradley Hartgerink, Bureau of Medicine and Surgery (BUMED), USN; Dr. Joy Miller and Mr. Christopher Decker, National Intelligence Council (NIC); and Dr. Richard Hatchett, National Security Council, The White House.

Travel to the five overseas infectious disease laboratories was a significant component of our project. Appendix E details our itineraries and the laboratory partners and collaborators with

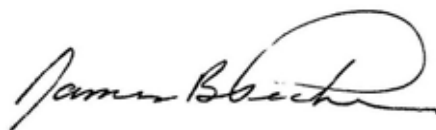
whom we met. Their perspectives and experiences proved essential to understanding the laboratories' contributions to military medicine, public health, and regional research capacity.

For their tremendous generosity in opening their doors, sharing their research portfolios, and assisting with logistical and administrative details, we are thankful to the laboratories' commanding officers, department heads, researchers, and staff, in particular: in Peru, Captain John W. Sanders (NAMRU-6 Commanding Officer), Mrs. Lucy Rubio, Mrs. Roxana Lescano, Dr. Andres Lescano, and Dr. Amy Morrison; in Kenya, Colonel Thomas M. Logan (USAMRU-K Commanding Officer), Captain Richard Wood, Jr., Lieutenant Colonel Shon Remich, Lieutenant Colonel Eyako Kofi Wurapa, Lieutenant Colonel Maria Bovill, and Dr. Douglas Shaffer; in Egypt, Captain Robin M. Wilkening (NAMRU-3 Commanding Officer), Dr. Moustafa Mansour, Lieutenant Commander David Rockabrand, Mr. Magued Ayad, and Mr. Michael Williams; in Thailand, Colonel Robert A. Bowden (AFRIMS Commanding Officer), Ms. Sodsee Aranyanak, Colonel Arthur Brown, Lieutenant Colonel John McNally, Lieutenant Colonel Stephen Thomas, Colonel Robert Gibbons, Major Stuart Tyner, and Major David Saunders; and in Hawaii and Cambodia, Captain Gail Hathaway (NAMRU-2 Commanding Officer, Pearl Harbor), Captain William Rogers (Laboratory Director, Phnom Penh), and Ms. Bun Chan Kesey.

In Washington, D.C., experts from government and the private sector shared their insights. We are grateful to Dr. John Boslego, Program for Appropriate Technology in Health (PATH); Dr. William Lyerly, U.S. Department of Homeland Security (DHS); Commander David Blazes, USN, AFHSC-GEIS; Lieutenant Commander David Brett-Major, USN, BUMED; Dr. Harrison Spencer, Association of Schools of Public Health (ASPH); Ms. Tanya Baytor, Georgetown University Law Center; Dr. Richard Love, National Defense University; Colonel Dan Harms, USA (retired), Booz Allen Hamilton; Colonel Jerome Kim, Dr. Tiffany Hamm, Dr. Sheila Peel, and Dr. Paul Scott, WRAIR; and Ms. Cheryl Carr, NMRC.

Thanks as well to the CSIS team: Dr. J. Stephen Morrison, for conceptualizing and overseeing the project; Michèle Ledgerwood, for organizing the project's research, travel, and meetings; Seth Gannon, for extensive research and writing; Dr. Katherine Bliss, for her expertise on the trip to Peru; Dr. Jon Alterman and Dr. Phillip Nieburg, for expertise on Egypt and Kenya; and Carolyn Schrote, for her invaluable organizational and logistical support. The report also benefited from the editorial contributions of James Dunton of CSIS and Vinca La Fleur of West Wing Writers.

Finally, despite the substantial contributions of experts outside of CSIS, this report is not the product of consensus among them. The opinions and recommendations set forth are solely those of the authors, as are all errors in fact and judgment.

A handwritten signature in black ink, reading "James B. Peake". The signature is fluid and cursive, with a large, stylized "P" at the end.

Lieutenant General James B. Peake, MD (USA Ret.)
Chair, CSIS Project on the DoD Overseas Medical Research Laboratories



EXECUTIVE SUMMARY

For the past 60 years, the United States Army and Navy have relied on Department of Defense (DoD) overseas medical research laboratories to protect U.S. forces deployed overseas from indigenous infectious diseases, such as malaria, dengue, and Japanese B encephalitis. These laboratories currently include the U.S. Army Medical Research Unit in Nairobi, Kenya (USAMRU-K); the Armed Forces Research Institute of Medical Sciences (AFRIMS) in Bangkok, Thailand; the U.S. Naval Medical Research Unit 3 (NAMRU-3) in Cairo, Egypt; NAMRU-6 in Lima, Peru; and NAMRU-2 Pacific, temporarily headquartered in Pearl Harbor, Hawaii. A sixth laboratory, USAMRU-E in Heidelberg, Germany, conducts psycho-social research. In March 2011, the precursor to a new U.S. Army laboratory, the Central Public Health Reference Laboratory, officially opened in Tbilisi, Georgia.

The Army and Navy overseas laboratories contribute fundamentally to U.S. military readiness—their core function—through medical research tied directly to the protection of deployed personnel. In addition, the laboratories’ development of products such as vaccines, therapies, medical devices and new prophylactic drugs brings shared health benefits to the world at large, strengthens the scientific community in the host country, and attracts other U.S. government agencies (NIH, CDC, USAID), as well as multiple university, business and foundation partners, eager to advance field trials and other scientific research in an endemic disease environment. At the same time, the laboratories contribute substantially to related scientific activities, most notably global detection of emerging and re-emerging disease threats, while helping to build military-to-military collaboration and local medical and scientific capacity. They are also active and valued participants in U.S. Embassy country teams, the in-country face of U.S. diplomacy.

The laboratories are exceptional: in their contributions to core readiness; in their unusual longevity and resilience, especially in the face of multiple adversities; in their sustained contributions to scientific research and global health; and in their extensive local and regional networks of partners. No less important, their lean budgets and organizational agility make them a conspicuous “best buy,” an ever more important selling point in an age of austerity when pressures have mounted to invest in cost-effective organizations that yield a clear return on a modest investment.

In spite of these special assets, the DoD overseas medical research laboratories face inherent vulnerabilities, and operate under several constraints and challenges that impede their performance.

They remain surprisingly under-recognized and undervalued outside the research community, with few high-level champions in key positions of policy authority. While they are regarded as indispensable by host government agencies and different partner institutions in the regions within which they operate, as well as by USG and private entities with which they collaborate on the ground, the laboratories remain under-resourced, both in funding and personnel; and their value and achievements are poorly appreciated at policy levels within Congress and the Executive branch.

Part of the challenge, as with all medical research, is that metrics to quantify their achievements are difficult to formulate. Success stories are often not well communicated to key non-health audiences; and there is no integrated communications strategy for promoting the laboratories' purpose and value. These factors contribute to persistent funding uncertainty and put the laboratories at risk of having to cut back or eliminate critical research programs, threatening their long-term viability.

It is our strong opinion that the U.S. Army and U.S. Navy overseas laboratories will continue to be of vital importance to military readiness, to successful DoD operations, to American bench research on infectious diseases, and to the broader U.S. global health agenda. But reforms are required for the laboratories' future performance to be optimal and sustained:

- First, the laboratories need more sufficient, predictable, and sustainable core funding;
- Second, they need a more effective communications strategy tailored to reach senior DoD, Congressional and global health constituencies;
- Third, research efforts should be better integrated across the DoD medical research laboratories;
- Fourth, Army and Navy personnel requirements should be more conducive to medical research; and,
- Fifth, DoD should look strategically at where new challenges will emerge and require additional medical research capabilities, and how the Army and Navy's laboratory assets can best be used to meet them.



THE DEFENSE DEPARTMENT'S ENDURING CONTRIBUTIONS TO GLOBAL HEALTH

History of the Laboratories

Today's Army and Navy overseas medical research laboratories have roots dating back to the 19th century. The Walter Reed Army Institute of Research (WRAIR), which oversees the U.S. Army's international network of laboratories, traces its institutional heritage to the Army Medical School, founded in 1893 by pioneering bacteriologist Brigadier General George Miller Sternberg, U.S. Army Surgeon General. In 1898, Sternberg also established the Army's first two overseas laboratories in Cuba and the Philippines to investigate outbreaks of typhoid fever and yellow fever, which were undermining U.S. military efforts during the Spanish-American War.

The Naval Medical Research Center (NMRC), which oversees the U.S. Navy's laboratories, falls under the Navy's Bureau of Medicine and Surgery (BUMED), established in 1842. The first domestic Naval Medical Laboratory was built on the grounds of the Brooklyn Naval Hospital in 1853.

During the twentieth century, military overseas laboratories were established successively in response to real or anticipated wartime medical needs. Their focus was on infectious disease research, including vectors, reservoirs, and origins. Considerable scientific innovation sprung from these precursor laboratories during both World Wars, with investigations into dengue, malaria, combat stress, and other established or emerging threats to U.S. troops. It was during this period that the U.S. Army began developing the first vaccine for Japanese B encephalitis (JE).

By the end of the Second World War, the need was clear for a more permanent cadre of overseas medical research units in countries where infectious diseases of concern to U.S. troops were both native and endemic, and where strong local collaborative partnerships could be formed.

Thus, NAMRU-3 was established in 1942 in Egypt, commissioned in 1946; NAMRU-2 was established in 1945 in Guam, later reestablishing its headquarters in Taipei (1955–1979), Manila (1979–1991), Jakarta (1991–2010), and Pearl Harbor (2010–present); AFRIMS was founded in 1958 in Thailand as the Cholera Research Laboratory of the Southeast Asia Treaty Organization (SEATO), renamed AFRIMS in 1977 when SEATO was dissolved; USAMRU-K was activated in 1969 in Kenya, commissioned in 1973; and NAMRU-6 was established in Peru in 1983 as a Detachment, becoming a full Command in January 2011.

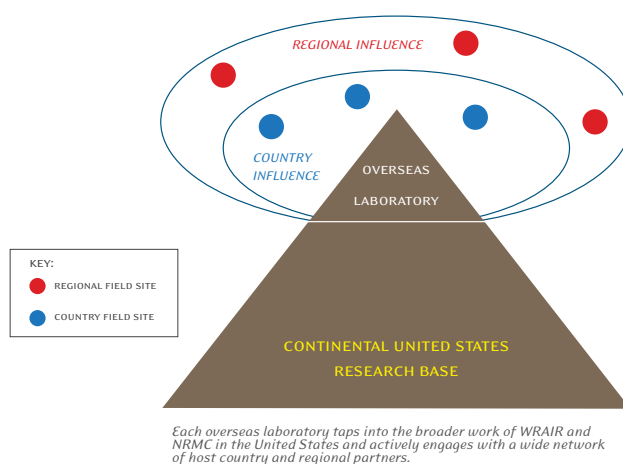
The Value of the DoD Overseas Medical Research Laboratories

The achievements of the Department of Defense (DoD) overseas medical research laboratories rest on several core assets.

Military Readiness Mission

The laboratories' scientific and public health contributions over the past six decades grow out of the fulfillment of their mission to protect U.S. military forces. To meet U.S. national security obligations, U.S. troops must be prepared to deploy on short notice to any region of the world, and be equipped to handle multiple contingencies—including myriad diseases not indigenous to the United States and to which U.S. troops lack acquired immunity and thus are more susceptible. Establishing military laboratories in areas where these diseases are endemic has effectively served this readiness need, for example, with the development of prophylactic anti-malarial drugs.

The laboratories' military identity, often perceived as a potential vulnerability, actually contributes to their success. The laboratories are not disaggregated entities scattered around the world but, rather, are part of a global structure that provides personnel, logistical support, and broad competencies. The laboratories receive leadership and oversight from the Walter Reed Army Institute of Research (WRAIR) and the Naval Medical Research Center (NMRC), the overarching organizations that direct their activities. In addition, the military's emphasis on performance and its interest in long-term outcomes facilitate a strategic, patient outlook conducive to medical product development and compliance with research norms and FDA standards.



Contributions to Global Health

The U.S. Army and U.S. Navy laboratories bring broad global health benefits beyond their immediate mission of force health protection. The DoD laboratories' focus on developing products such as prophylactic and therapeutic drugs, vaccines, and scientific knowledge, and their ability to conduct Phase III clinical trials in indigenous areas, result in medical advances that not only save the lives of men and women in uniform, but also have dramatic health benefits for all populations vulnerable to neglected diseases. In many important instances, the DoD laboratories' findings have helped mitigate or eradicate diseases on a global scale, as well as identified or diagnosed previously unknown pathogens.

Examples are the laboratories' research that resulted in the first vaccine for Japanese encephalitis virus (JE); the first isolation of the Rift Valley Fever virus (RVF); the first identification of new strains of dengue fever in Peru; the demonstrated efficacy of Malarone, primaquine, and weekly

tafenoquine to treat and prevent malaria; and, in Thailand, the first successful HIV/AIDS vaccine trial. Although the HIV/AIDS vaccine tested at AFRIMS is less than one-third effective, the DoD laboratory has been the only entity out of many to accomplish this difficult and challenging task. In addition, WRAIR has maintained the only accredited diagnostic laboratory for leishmaniasis and the only American drug discovery and development program for malaria. As these examples demonstrate, the laboratories' work is often especially valuable to low- and middle-income countries, where the impact of these diseases is greatest.

“NAMRU-2’s mission of militarily-relevant research leads them to focus on an extraordinarily wide range of diseases. This depth and breadth of knowledge is of great benefit to a country such as Cambodia, which has very little scientific capacity. NAMRU-2’s research is helping Cambodia develop and clarify its national public health research agenda.”—*National Institute of Public Health, Ministry of Health, Cambodia*

Adaptability

The laboratories are highly adaptive and responsive. Within the boundaries of their mission, the DoD laboratories have been agile in responding to specific outbreaks or medical concerns, including cholera (AFRIMS, Thailand); trypanosomiasis (USAMRU-K, Kenya); hepatitis and HIV (NAMRU-6, Peru); and typhus (NAMRU-3, Egypt). Over the years, as diseases have been contained and drugs and vaccines successfully developed, the DoD laboratories have successfully and cost-effectively refocused their research objectives to respond to new outbreaks and to local public health emergencies.

Today, the laboratories' research and disease detection portfolios include tracking the evolution of new strains of malaria, dengue fever, leishmaniasis, Rift Valley fever, influenza virus (including avian influenza H5N1 and pandemic influenza H1N1), enteric pathogens, retroviruses including human immunodeficiency virus (HIV), and emerging infections. The laboratories incorporate sophisticated entomology departments and insectaries, and several include veterinary medicine programs required to conduct state-of-the-art research.

The Army and Navy overseas laboratories maintain a strong capacity for disease detection, functioning as sentinel outposts to detect emerging or re-emerging diseases that could threaten deployed troops or other vulnerable populations. The Armed Forces Health Surveillance Center's Global Emerging Infections Surveillance and Response System (AFHSC-GEIS) funds the majority of the laboratories' extensive disease detection activities. GEIS has successfully leveraged the laboratories' extensive geographic reach, networks of partners, portfolio of bench research, and state-of-the-art diagnostic capabilities. The DoD overseas laboratories have used GEIS funds to build local disease detection capacity, fund training programs, and contribute to American and international outbreak detection and response networks. Their disease-detection mission provides critical data for disease risk assessments, prioritization of bench research programs, and funding of product development by the Military Infectious Disease Research Program (MIDRP).

“AFRIMS has a truly global disease focus. As a result, the laboratory has a remarkable reachback capacity into a wide variety of response networks. When Thailand has experienced outbreaks from food-borne botulism, for example, AFRIMS has been able to reach out immediately to its global partners to help Thai medical doctors secure the required antitoxins.”—Royal Thai Army

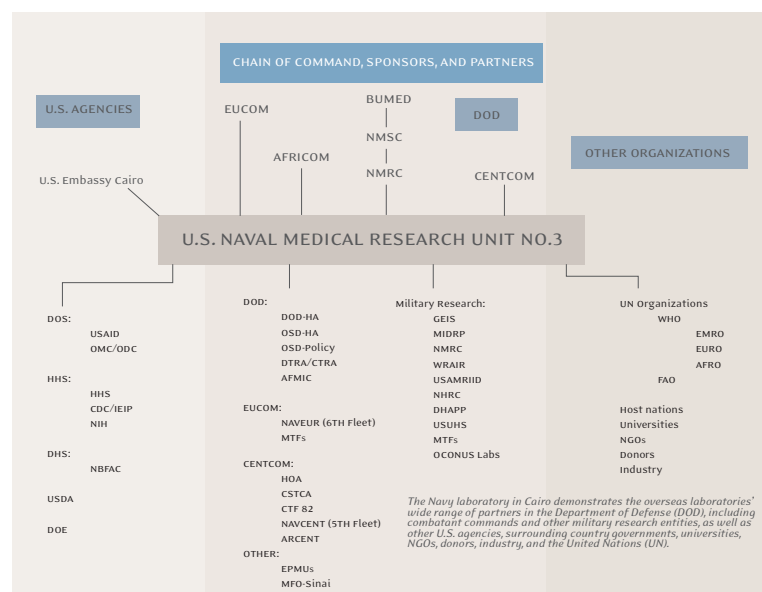
In 2006, the Centers for Disease Control and Prevention (CDC) embedded a new Global Disease Detection and Response Center (GDDRC) site in NAMRU-3, both physically in the Navy laboratory’s offices and organizationally as part of its command structure. This mutually beneficial collaboration provides NAMRU-3 increased funding and improved disease detection capability, while CDC’s disease detection activities benefit from NAMRU-3’s infrastructure and longstanding local relationships.

The results of these collaborations between GEIS, CDC, the overseas laboratories, and their partners include an influenza detection network throughout Africa, the Middle East, Eastern Europe and Central Asia; malaria detection along the Cambodian border regions, including emerging drug resistance; detection of the first human cases of avian influenza in Egypt; predictive models for Rift Valley fever in Kenya, in partnership with the U.S. National Aeronautics and Space Administration (NASA); ALERTA, an electronic disease detection system with comprehensive coverage of the Peruvian military; disease detection programs in all 27 Egyptian governorates; and direct translation of epidemiological data from Nepal into new northern hemisphere vaccine strains for Influenza A (H3N2).

Innovative Partnerships

The DoD laboratories have developed extensive collaborative networks that multiply the impact of their limited budgets. For each laboratory, the diversity of partnerships is striking—including

international organizations, nongovernmental organizations (NGOs), scientific research institutes, universities, private businesses, foundations, government agencies (U.S., host nation, and regional), community organizations, local schools and clinics, and national militaries. While the laboratories are closely tied to their host nations, each laboratory is also the central node for a wide array of research and disease detection activities throughout the region.



Reflecting their regional expertise, the World Health Organization (WHO) has designated NAMRU-3 and AFRIMS as WHO Collaborating Centers; and has designated NAMRU-3 and USAMRU-K as WHO Reference Laboratories, recognizing them as centers of excellence. These designations greatly enhance the laboratories' legitimacy and perceived reliability in the eyes of potential partners.

As military institutions, the laboratories have been able to forge collaborative military-to-military relationships in neighboring countries such as Tanzania where the military is responsible for healthcare. The Army and Navy overseas laboratories' military-to-military work is closely related to their force health protection mission. Improving military medicine among allied forces, especially those forces with substantial peacekeeping commitments, helps share the burden of regional security and makes the need to deploy American troops less likely.

The laboratories are also integrated into U.S. Embassy country teams and work closely with civilian agencies. U.S. Ambassadors and Deputy Chiefs of Mission (DCMs) are strong advocates for the laboratories, and are directly engaged in overseeing their activities. The National Institutes of Health (NIH), the U.S. Agency for International Development (USAID), CDC, and the Peace Corps have been able to leverage the laboratories' infrastructure, research, partnerships, and cohorts to build, expand, and improve their own activities. There have been some interagency tensions, in Washington as well as in host countries, but, on balance, U.S. military researchers in the field have worked in close consultation with their civilian counterparts to enlarge the reach of their research, reduce duplication of effort, and improve outcomes.

The overseas laboratories have become increasingly attractive research partners for U.S. foundations, corporations, and research universities, owing to their multiple assets: their scientific competence, their longevity in the regions in which they operate, their fiscal efficiency, the diversity of their research portfolios, and the trust of the medical establishment in their host countries, leading to productive local collaboration.

“Partnering with USAMRU-K has helped the Ministry of Defense develop a formal, strategic program for addressing HIV in the Kenyan military. This program has resulted in 95% HIV status awareness as well as retroviral treatment for 100% of soldiers who test positive. USAMRU-K helped increase training programs and expand Kenyan military laboratory services. The MOD now requests that other U.S. government agencies work with the Kenyan military through USAMRU-K, particularly with respect to PEPFAR.”—
Ministry of Defense, Kenya

Resilience

The laboratories have achieved legitimacy, acquired a national brand identity in their host countries, and demonstrated remarkable durability.

The laboratories in Peru, Kenya, Egypt, Thailand, and Cambodia are perceived by the host countries as national assets. Each of the laboratories has a clear local sponsor, a governmental department with which it collaborates most closely, and which frequently acts as its advocate and conduit to higher echelons of the host government. Through their extensive capacity-building activities, their reliance on locally hired research personnel, and their focus on diseases of local relevance, the Army and Navy laboratories have become integrated into the public health efforts of their host nations.

“The presence of NAMRU-6 provides Peruvian scientists with unprecedented in-country, specialized training in fields such as bacteriology, parasitology, and virology. The laboratory also facilitates partnerships with a vast network of American universities. This incomparable outreach capability has enabled Peruvian research universities to recruit exceptional faculty and students.”—
Faculty from San Marcos University and Cayetano Heredia University, Peru

Building local capacity is a vital component of the DoD laboratories’ medical research activities. In order to conduct human clinical trials that test products developed to prevent and treat indigenous diseases, the Army and Navy laboratories provide training and equipment to community clinics and hospitals, as well as to partner agencies in their national host governments. At field sites, such as Kamphaeng Phet for AFRIMS, Iquitos for NAMRU-6, and Kericho for USAMRU-K, the DoD laboratories have renovated clinics and local laboratories and trained local staff in management and medical research. In addition to sponsoring local Master’s

Degree programs, the overseas laboratories often make their resources available as educational tools. A generation of Egyptian doctors and researchers has benefited from the NAMRU-3 medical library, for example.

These capacity-building activities are notable for their regional reach. USAMRU-K’s Malaria Diagnostic Center in Kisumu has trained hundreds of scientists from over 22 countries in malaria microscopy, a difficult but essential skill. NAMRU-6 is active in every South American country except Brazil and Chile, which already boast strong research infrastructures. Similarly, WHO sees NAMRU-3 as a critical partner in building capacity throughout the WHO Eastern Mediterranean region. The training it provides in epidemiology and disease detection is helping the region prepare for and respond to potential pandemics.

As a result of these factors, each of the DoD overseas laboratories, with the exception of NAMRU-2, has established a strong brand identity. Noticeably, in both Kenya and Peru, the laboratories are still commonly known by their original names, USAMRU-K as the Walter Reed Project and NAMRU-6 as NAMRID (Naval Medical Research Institute Detachment).



Branding reflects the laboratories' success in achieving broad legitimacy and serving a useful function in their host societies. It has contributed significantly to their longevity, even during times of turmoil and adversity: NAMRU-3 was the sole U.S. entity operational in Egypt during the Six-Day War with Israel and the seven-year break in diplomatic relations with the United States that followed. NAMRU-6 maintained its presence in Peru despite the internal conflict of the late 1980s and early 1990s. USAMRU-K weathered the interethnic violence and mass displacement that followed Kenya's December 2007 national elections. AFRIMS maintained its presence in Bangkok through many government changes, including the political turmoil following the recent 2006 coup.

“For fifty years, AFRIMS has made sustained and significant contributions to Thailand and to the region. The laboratory is critical to scientific human resource development, providing everything from laboratory diagnostics to clinical trials to field epidemiology training to thesis committees for students at the university. They are always adaptive to new challenges, and their doors are always open to their local partners.”—Mahidol University, Faculty of Tropical Medicine, Bangkok, Thailand

Enduring Challenges

Despite these core strengths, the laboratories also face challenges that, if not managed effectively, can greatly impede their current and future performance.

Weak Baseline Funding

In FY2010, the budget of the four most active laboratories (AFRIMS, NAMRU-3, NAMRU-6, and USAMRU-K), not including personnel costs for the relatively small number of active duty U.S. military officers at each laboratory, was in aggregate a modest \$100 million.

To maintain this funding, the laboratories have developed entrepreneurial and academic funding strategies, pursuing private sector partners and competing for research grants. Most of the DoD laboratories' funding is contingent on grants, competitive proposals to DoD sponsors, and cooperative research agreements with the NIH, CDC, USAID, universities, and private industry, leaving their budget uncertain during the fiscal year. While these necessities have made the laboratories lean and efficient, their limited and unpredictable budgets, combined with increased competition for external research funds, threaten the scientific capabilities on which the laboratories rely to achieve their military readiness mission.

This chronic deficiency in core funding motivates the laboratories to take on research and program opportunities beyond their primary missions of product development and disease detection. Although these ancillary activities bring in significant funding and benefit global health and the U.S. military, they require infrastructure, personnel, and time-dependent research to satisfy contracts, threatening to crowd out the laboratories' primary missions. Indeed, laboratory commanders and bench scientists remain concerned that they are increasingly perceived as “fee-for-service” organizations.

Another potential secondary mission for the Army and Navy laboratories comes from the Defense Threat Reduction Agency (DTRA), which historically has focused on biological threat reduction in the former Soviet Union. The agency's more recent Cooperative Biological Engagement Program (CBEP) seeks to expand this focus to broader infectious disease surveillance. However, DTRA shares neither the DoD overseas laboratories' focus on locally relevant public health research nor their delicate relationships with host governments. The overseas laboratories do not have the biosafety level 4 (BSL-4) infrastructure required to handle the pathogens of concern to DTRA, and their scientists do not have the requisite training to handle these select agents. Any expansion of DTRA activities at the DoD overseas medical research laboratories must be carefully managed.

Military Identity

The laboratories' military identity—on balance, a great strength—is an inherent vulnerability if the overall political climate becomes volatile or hostile, placing stress on the bilateral relationship between the United States and the host country. Occasionally, media, parliamentarians, government officials, or independent critics in the laboratories' host countries float allegations that research is conducted for offensive purposes such as weaponization, rather than for defensive ones such as troop protection and public health. In several countries in which the laboratories currently

operate—most notably Egypt—there have been charges in the media of biological experimentation on patients or the development of a biological weapons program. These inaccurate accusations risk undermining host nation support for the laboratory and require ongoing vigilance and special care to counter effectively.

Local partners have thus far been quick to react and to publicly defend the laboratories against accusations of illegal research or inappropriate conduct. The abrupt end to NAMRU-2 operations in Indonesia, however, provides an instructive, exceptional case. Indonesia initiated a still ongoing international debate about the World Health Organization's use of biological samples, asserting national sovereignty over viral specimens and requesting an equitable distribution of vaccines and drugs derived from those specimens. Although NAMRU-2 was careful to respect Indonesia's sovereignty over and ownership of its samples, the absence of a strong in-country advocate was detrimental to the laboratory. Indonesia's bilateral relationships with multiple countries, including the United States, became strained at a high level over the WHO controversy, and tensions and confrontations escalated, fed from multiple directions. The Appendix on NAMRU-2 Jakarta provides greater detail on this sequence of events.

In other countries, the laboratories' local sponsors have vigorously defended the value and legitimacy of their work: the Peruvian Navy for NAMRU-6; the Royal Thai Army for AFRIMS; the Egyptian Ministry of Health (MoH) for NAMRU-3; the Kenya Medical Research Institute (KEMRI), which reports directly to the Kenyan MoH, for USAMRU-K; and the Cambodian MoH for NAMRU-2's laboratory detachment in Phnom Penh, Cambodia.

The laboratories' U.S. military identity will require them to continue to cultivate strong local relationships and partnerships, to convey effectively to a public audience the value of their contributions to local public health, and to be open and transparent in rebutting erroneous but potentially damaging charges.

In light of these considerations, pursuing suggestions to involve the overseas laboratories in biological threat reduction could raise the risk of new accusations by suggesting involvement in non-medical intelligence activities, a perception that conceivably could threaten the laboratories' longstanding relationships. The trust the laboratories create with partner governments is based on a shared humanitarian and scientific mission, not on the collection of information.

Another challenge of medical research as a military institution is operating within the confines of Army and Navy personnel policy. Overseas tours of duty last two to three years, resulting in staff turnover that constrains the institutional memory necessary to long-term research projects;

“NAMRU-3 is the reference laboratory for Egypt and for the region. They are the laboratory that the government trusts during an emergency or outbreak. The World Health Organization runs all regional samples through them. They are always willing to open their facilities after hours, as their virology team did in the middle of the night in February, 2006, to diagnose and confirm Egypt's first case of H5N1 Avian influenza. NAMRU-3 provided the results to the Ministry of Health within hours.”—
Ministry of Health, Egypt

impedes mentorship of younger scientists; hinders the career progression of scientists who rarely see their research through to completion; and adversely affects personal working relationships with in-country partners. Although medical research differs greatly from other military deployments, performance is evaluated on the same criteria. As a result, a tour at an overseas laboratory can lower an officer's chance at promotion.

Undervalued at Home

The activities of the overseas laboratories often are poorly understood and undervalued in the United States. Even as strategic assets of the U.S. military, and despite their many contributions to global public health, they have too few champions within the upper ranks of Army and Navy medicine, the senior leadership in the Office of the Secretary of Defense, the Joint Staff, the Combatant Commands, and the authorizing and appropriations committees in Congress.

There are a number of reasons for this limited domestic support. The laboratories lack a targeted and strategic plan for outreach and communications; and their remote locations, small number of personnel, and diminutive fraction of the U.S. defense budget make it all the harder to garner attention and cultivate champions in Washington.

Recommendations

The DoD overseas medical research laboratories are a success story, a complex operation with exceptional assets, and remain of vital importance to U.S. national interests.

To guarantee their future success and sustainability, the following measures should be pursued and implemented:

1. Congress should provide the programmed funding necessary to maintain the laboratories' core scientific capabilities.

In April 2008, the leadership of WRAIR, NMRC, and the overseas laboratories developed a consensus statement on the laboratories' core capabilities, which provide the foundation for the laboratories' research and disease detection efforts and enable them to accept militarily relevant projects from external sponsors.

Together, the Navy laboratories receive approximately \$8 million in annual core funding to maintain these capabilities. The Army laboratories do not receive such funding, although they hope to for the first time in FY2012. Yet, even if the Army laboratories begin to receive funding comparable to the Navy, the overseas laboratories in total will remain \$22-25 million short of the annual funds required for the equipment, maintenance, and local personnel necessary to sustain this full range of core capabilities.

2. Congress should provide the laboratories additional annual funding of approximately \$20 million for core research projects. To provide these resources, the Military Infectious Diseases Research Program (MIDRP) should receive additional programmed funding specifically targeted to support these projects at the overseas laboratories.

MIDRP—the funder most closely aligned with the laboratories' core mission of developing medical products in the interest of military readiness—provided only 3% of the FY2010 budget for

NAMRU-3 (under \$1 million) and only 10% for NMRCDC (\$1.4 million). The Army labs in Kenya and Thailand had only 12% (\$4.2 million) and 24% (\$5.2 million) of their respective FY2010 financial inflows available for Research, Development, Test, and Evaluation (RDT&E).

Relatively modest increases in MIDRP funding would restore an appropriate balance between the laboratories' primary and secondary missions. While more predictable funding for militarily relevant research would provide stability, it would not undermine the incentives for entrepreneurialism that have made the laboratories successful and cost-effective.

This proposal requires an increase in MIDRP's overall budget. It would be counterproductive to reprogram MIDRP funding toward the overseas laboratories while offsetting that funding with decreases in other Army and Navy medical research activities.

3. The laboratories should make a concerted effort to increase the visibility, understanding, and support of DoD overseas research programs among key target audiences. Initiatives should include:

- *Creating an annual Forum on DoD Overseas Medical Research*, which would convene representatives of the laboratories, Army and Navy Medicine, the Joint Staff, the Office of the Secretary of Defense, the Combatant Commands, and the National Security Council to discuss the laboratories' achievements and future plans.
- *Working closely with DoD's legislative liaison staff to increase Congressional awareness of the laboratories' activities*, through regular appearances by laboratory leadership on Capitol Hill, including hearings, briefings, and private consultations that concentrate on authorizing and appropriating committees in both chambers; as well as a focused effort both to bring Congressional Delegations (CODELs) to the overseas laboratories and to show members of Congress the central WRAIR and NMRC laboratories in nearby Silver Spring, MD. Presenting the laboratories' work in person to authorizers and appropriators is invaluable.
- *Reaching out to current and prospective business, university, and foundation partners, as well as other USG agencies*. The laboratories should release a polished, user-friendly annual compendium of successes that makes an easily understood, quantitative case for the laboratories as a useful research platform. To this end, the laboratories need clearer metrics—the number, for example, of U.S. and allied soldiers inoculated or treated with products the laboratories developed—to assess and explain their contributions to military readiness, local capacity, global public health, and disease detection. The laboratories should also develop a unified Internet and social media strategy, including specialized media training for officers in each laboratory and targeted electronic outreach to the laboratories' many scientific alumni.

4. The laboratories should continue to pursue greater integration and collaborative planning.

While the Army and Navy laboratories, along with MIDRP and AFHSC-GEIS, deserve credit for their successes in coordination, they should continue to work toward greater integration in planning, particularly with new teleconference technologies. Departments pursuing similar research at different laboratories—entomology, for example—should coordinate research plans whenever possible to maximize the exchange of ideas and reduce inefficiencies.

As part of the enhanced outreach strategy outlined in recommendation 3, the laboratories should pursue a single, unified set of documents, presentations, and Internet resources made available to DoD, Congress, and external partners.

5. The Army and Navy should modify personnel requirements for medical researchers.

Allowing tours of duty at the overseas laboratories to be five years or longer would minimize the disruptive effect of turnover and accelerate the development of militarily relevant medical products. Similarly, a dedicated career track in medical research, as well as opportunities for joint assignments with other agencies such as CDC, would provide improved incentives for successful research and help the overseas laboratories continue to attract top scientific talent. When deployed in combat settings, officers in a career track for medical research would bring uniquely valuable regional knowledge and scientific and public health expertise.

6. The Department of Defense should undertake an initiative to chart how future laboratories can best seize important emerging opportunities and adapt rapidly to critical new challenges.

While we expect the current laboratories to endure and continue their research successes, their history suggests that new crises and emerging disease threats will create urgent medical research demands in other locations. NMRC and WRAIR should partner to take a strategic look at the future and how their shared assets can be best used to respond to fast-breaking future needs, including the prospect for new regional operations.



APPENDIX A SELECTED ACHIEVEMENTS

Armed Forces Research Institute of Medical Sciences (AFRIMS)–Thailand

- Conducted Japanese Encephalitis Virus (JE) vaccine Phase III trial with 63,000 children; vaccine approved by FDA in 1992.
- Developed Typhoid Vi Polysaccharide vaccine, licensed by Federal Drug Administration (FDA) in 1994.
- Tested Havrix, a vaccine for Hepatitis A, licensed by FDA in 1995.
- Conducted first ever Hepatitis E (HEV) vaccine efficacy study in Nepal, resulting in the production of an HEV vaccine in 2003.
- Developed and carried out pre-clinical analysis of a *Plasmodium falciparum* Malaria vaccine (merozoite surface protein vaccine) in 2003.
- In collaboration with international partners, ran the world's largest HIV vaccine trial, RV-144 Phase III prime-boost vaccine combinations trial (2003–2009). The trial demonstrated partial vaccine efficacy (31.2%) and revitalized the field of HIV vaccine research.
- Conducted the first dedicated study of Artemisinin resistance in Cambodia (2006–2007) and established ongoing, long-term Malaria multi-drug resistance surveillance in 2009.
- World leader in Dengue research, with multiple active Dengue vaccine and drug trials.
- World Health Organization (WHO) Collaborating Center for training and diagnostics.
- College of American Pathologists (CAP) accredited retrovirology laboratory.
- “Top 5%” Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC) accredited animal laboratory.

Naval Medical Research Unit 3 (NAMRU-3)–Egypt

- Carried out research into the pathology and treatment of Cholera in the aftermath of the 1947 outbreak, reducing the death rate from 60% to less than 1%.
- Demonstrated the efficacy of Group A polysaccharide meningococcal vaccine (1973).
- Carried out the first ever isolation of Rift Valley Fever virus from two common mosquito species in Egypt, never before associated with RVF transmission (1977–1978).
- Completed a 400-child vaccine trial for Enterotoxigenic *Escherichia coli* (ETEC) in the Nile Delta (1995–1998).

- Detected the first human cases of Avian Influenza in Egypt in 2006; established an influenza surveillance laboratory network throughout Africa, the Middle East, Eastern Europe and Central Asia.
- Established an integrated National Egyptian Disease Surveillance System (NEDDS) for endemic and emerging diseases in all 27 Egypt Governates (2000–2007).
- WHO Collaborating Center for HIV/AIDS (1987), later for Influenza and Emerging Diseases.
- WHO Reference Laboratory for Avian Influenza since 2007.
- WHO Regional Reference Laboratory for Rotavirus surveillance in the Eastern Mediterranean Region.
- WHO Reference Center for Malaria diagnostics.
- College of American Pathologists (CAP) accredited laboratory (2010).

Naval Medical Research Unit 6 (NAMRU-6)—Peru

- Completed Cholera vaccine field efficacy trial in 18,000 volunteers in Peru (1993–1994).
- Conducted field efficacy trials resulting in region-specific national Malaria treatment policy (2000).
- In partnership with AFRIMS, developed a rapid diagnostic test for Malaria in 1996–2001, leading to FDA clearance of the Binax card test in 2007.
- Showed that Glucantime was more effective than Pentamidine for the treatment of cutaneous Leishmaniasis in Peru in 2005; also demonstrated the efficacy of topical Paromomycin.
- Completed field trial of two Yellow Fever vaccines in 1,000 children (2005).
- Made the first association of spotted fever Rickettsia with epidemic acute febrile illness in Peru (2004).
- Documented the introduction and spread of new Dengue strains into Northern Peru (2000–2001); more recently, carried out preclinical testing of a novel Dengue vaccine (patent pending).
- Provided critical sentinel surveillance and epidemiologic data utilized by multiple agencies in Latin America to define the spread of pandemic and non-pandemic strains of influenza; tested 5,796 samples for novel H1N1 between May and August, 2009.
- Completed four pivotal studies in the *Aotus nancymaae* model of traveler's diarrhea (2010).
- Developed non-human primate models for Campylobacter (2006) and Enterotoxigenic *Escherichia coli* (ETEC) (2004).
- Deployed ALERTA electronic disease surveillance system among Peruvian military (2005).
- Only facility in South America certified by the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC).

Naval Medical Research Unit 2 (NAMRU-2)–Pacific

- Identified amoxicillin resistance in *Vibrio Cholera* strains in Cambodia, leading to a change in the Cambodian national treatment policy for Cholera.
- Detected the first human cases of Avian Influenza in Indonesia in 2005. Until January 2007, diagnosed more cases of human H5N1 than any laboratory worldwide.
- Showed malarone (2002) and primaquine (2001) to be effective for the prevention of Malaria.
- Identified nH1N1 as the predominant cause of influenza in Cambodia in 2009–2010.
- Identified co-infection in patients with H5N1 virus and Coronavirus in Laos.
- Developed and deployed a computer-based Early Warning Outbreak Recognition System (EWORS) in Indonesia, Cambodia, Vietnam and Laos in 2001.
- In partnership with Duke University and National University Singapore, created a regional pathogen discovery network with partner countries including Sri Lanka, Vietnam, Singapore, Malaysia, Laos, and Cambodia.
- Developed and pioneered a menu-driven website for regional dissemination of outbreak data that was adopted by the 10-country ASEAN Health Secretariat (2000).
- Currently evaluating Dengue rapid antigen detection test kits.
- Conducts ongoing surveillance of drug resistant *P. falciparum* Malaria in Cambodia.

Army Medical Research Unit–Kenya (USAMRU-K)

- Conducted multiple Phase I/II HIV vaccine studies, including a 2006 study that was the largest in Kenya's history.
- Opened first integrated TB/HIV clinic in region through Kericho Field Station (2005).
- Established the first preventing mother-to-child transmission of HIV (PMTCT) program in the South Rift Valley Province in 2001, now the second largest in Kenya. In 2006, opened Phase III, NIH-sponsored, multi-centered therapeutics study that ultimately guided PMTCT policy in sub-Saharan Africa.
- Conducted multiple clinical trials through Kombewa field site, including Phase Ib Tb vaccine (2008) and MAL55 Phase 3 RTS,S Clinical Trial, which spanned 11 sites, seven countries, and 16,000 children (2009). Demonstrated RTS,S efficacy in HIV-positive children.
- Kombewa Clinical Research Center (CRC) conducted ten U.S. FDA-compliant Malaria drug trials between 1991 and 2008.
- Facilitated PEPFAR enrollment (Kericho Field Station), beginning in 2004. In 2008, enrollment surpassed 30,000 Kenyans in newly opened HIV clinics. 15,000 started ARTs; 200,000 women received PMTCT services; and over 100,000 individuals received HIV testing and counseling.
- Currently conducting Phase II clinical trial for Ferroquine for *P. falciparum* Malaria; surveillance for drug resistant *P. falciparum*; and Phase I clinical trial for Ebola-Marburg vaccine and Tuberculosis (TB) vaccine.

- Since 2004, the Malaria Diagnostic Center (MDC) in Kisumu has trained 846 laboratory technicians from 21 African countries plus the U.S., Ireland, and Thailand, and established 3 Malaria microscopy training centers.
- The USAMRU-K Clinical Research Center (CRC) is the first and only College of American Pathologists (CAP) accredited laboratory in Kenya (2008).

APPENDIX B

QUICK REFERENCE GUIDE TO THE LABORATORIES

AFRIMS (U.S. Army, Thailand)

Founded: 1959
U.S. military personnel: 26
U.S. civilian personnel: 1
Foreign Service Nationals: 114
Contractors and local personnel: 302
FY2010 budget: \$21.4 million

NAMRU-3 (U.S. Navy, Egypt)

Founded: 1946
U.S. military personnel: 21
U.S. civilian personnel: 17
Contractors and local personnel: 250
FY2010 budget: \$28.2 million

USAMRU-K (U.S. Army, Kenya)

Founded: 1969
U.S. military personnel: 15
U.S. civilian personnel: 2
Foreign Service Nationals: 2
Contractors and local personnel: 600
FY2010 budget: \$36.3 billion

NAMRU-6 (U.S. Navy, Peru)

Founded: as detachment, 1983; elevated to
command level, 2011
U.S. military personnel: 14
U.S. civilian personnel: 3
Foreign Service Nationals: 204
Contractors and local personnel: 117
FY2010 budget: \$13.9 million

NAMRU-2 (U.S. Navy, Cambodia detachment)

Founded: NAMRU-2 in 1945; detachment
in Cambodia in 1988
U.S. military personnel: 2
Foreign Service Nationals: 7
Contractors and local personnel: 84
FY2010 budget: \$10.1 million

Note: Foreign Service Nationals are native citizens of the host country or third-country citizens who are career employees of the U.S. government.



APPENDIX C BUDGETS

The six Army and Navy overseas medical research laboratories operate on relatively small annual budgets. In aggregate, their FY2010 budget—which includes competitive grants, funds from non-governmental sources, and non-research activities, but does not include personnel costs for the laboratories’ small number of active duty U.S. military officers—totaled just over \$110 million. That figure comprises approximately \$36.3 million at USAMRU-K, \$28.2 million at NAMRU-3, \$21.4 million at AFRIMS, \$13.9 million at NAMRU-6, \$10.1 million at NAMRU-2, and \$1.2 million at USAMRU-E.

The laboratories’ core research mission represents a very limited portion of these annual budgets. This is true for both the Army and the Navy laboratories, although they differ in important respects.

The Military Infectious Diseases Research Program (MIDRP)—the funder most closely aligned with the laboratories’ core mission of developing medical products in the interest of military readiness—provided 2.5% of the FY2010 budget for NAMRU-3, 8.6% for NAMRU-6, and 10.5% for NAMRU-2, primarily for continuing NAMRU-2 operations in Cambodia. Only 12% and 24% of the FY2010 financial inflows at USAMRU-K and AFRIMS respectively were available for Research, Development, Test, and Evaluation.

While the Navy laboratories receive core funding for management expenses—approximately \$2.2 million in Peru and \$3.9 million in Egypt—the Army laboratories are forced to draw on their research budgets for general and administrative overhead, as allowed. The Army laboratories’ operations and management funding (OMA) goes only to personnel costs. In FY2010, AFRIMS and USAMRU-K managed their other overhead expenses with approximately \$6.1 million taken from research protocols—compared to \$8.5 million in 2008 and \$9.5 million in 2009.

The chronic deficiency in funding for their research and development mission is one of the pressures that have motivated the Army and Navy laboratories to embrace other important missions that bring additional resources. On the Navy side, disease detection programs for the Armed Forces Health Surveillance Center Global Emerging Infections Surveillance and Response System (AFHSC-GEIS) constituted over 19% of the NAMRU-3 budget in FY2010. NAMRU-3 also hosts a CDC Global Disease Detection and Response Center (GDDRC), which is the largest single component of the Egypt laboratory’s budget at 26%. GEIS support was a full 35% of NAMRU-6’s FY2010 budget—three and a half times MIDRP’s contribution to the same lab.

The Army laboratories also have undertaken substantial disease detection work. AFRIMS received over 20% of its budget from AFHSC-GEIS in FY2010. USAMRU-K receives similar GEIS support in dollar amounts, but that support represented only 17% of its FY2010 budget, thanks to the large proportion of funding the Kenya lab receives from PEPFAR. Despite the growth in GEIS

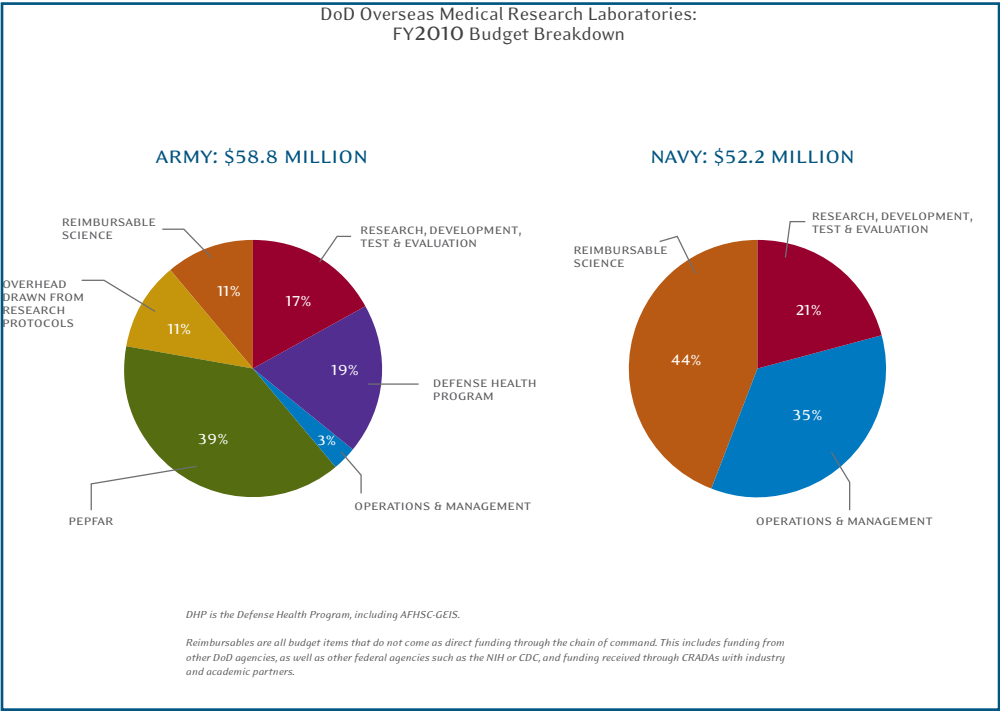
budgets over the last decade, the current expectation is that GEIS funding for the laboratories will remain flat in the near to medium term.

USAMRU-K implemented over \$23 million in PEPFAR treatment programs in 2010 that accounted for two-thirds of USAMRU-K's 2010 budget. Since 2004 the expansion of PEPFAR operations in Kenya has been largely responsible for the dramatic growth in USAMRU-K's budget, from \$4.3 million in FY2003 to \$36.3 million in FY2010. The PEPFAR funds received by USAMRU-K are used to support a variety of HIV/AIDS care and treatment programs, some of which complement and facilitate but do not fund USAMRU-K's HIV/AIDS research agenda.

In the last several years, the Defense Threat Reduction Agency (DTRA), distinguished from the laboratories' other funding sources by its focus on biosafety and biosecurity, has accounted for a very modest proportion of the laboratories' operations, less than \$1 million combined in any given year. There is the possibility, however, that DTRA will offer increased funding as it gains interest in leveraging the Army and Navy laboratories' disease detection activities for its biological threat reduction mission. This funding is likely to remain minimal, however, unless the Army and Navy laboratories elect to fundamentally alter the nature of their research and disease detection activities.

The laboratories' entrepreneurial pursuit of additional funding in line with their core research programs also has resulted in relationships with partners outside of traditional DoD constituencies. In addition to their work with NIH, CDC, and PEPFAR, the Army and Navy laboratories have built a complex network of public-private partnerships, founded on Cooperative Research and Development Agreements (CRADAs) that create collaborative research efforts with universities, foundations, and private industry. Many of these projects draw upon grants from the NIH. Reimbursable projects, which include all funding from outside the laboratories' programmed chain of command sources, accounted for 27% of FY2010 operations. Funding from these sources increased dramatically over the last decade at every lab except NAMRU-2, which closed its operations in Indonesia, and USAMRU-K, where reimbursable work declined as PEPFAR work increased.

These complex budget dynamics create a degree of uncertainty, as the amount of money available to pursue the laboratories' core research and development mission fluctuates from year to year. The unpredictability of CRADAs and competitive grants mean that laboratory commanders have only a limited sense of their annual budget picture until the end of each fiscal year. While the laboratories have grown lean and entrepreneurial through necessity, their operations remain vulnerable to relatively small budget cuts or declines in research funding.





APPENDIX D

NAMRU-2 JAKARTA

NAMRU-2, originally established in 1945, set up a detachment in Jakarta, Indonesia, in 1970, at the invitation of the Indonesian Ministry of Health (MoH) under President Suharto, under a 30-year agreement. In 1991, because of political turmoil in the Philippines, it moved its command headquarters from Manila to Jakarta. The laboratory's scientific research in Indonesia consistently focused on naturally occurring tropical diseases of mutual interest to both countries. Its projects were carried out with the explicit approval of the National Institute of Health Research and Development (Badan LITBANGKES). In 2006, NAMRU-2's staff in Jakarta numbered 175, of whom 19 were American. Indonesian staff included 44 scientists holding Bachelor's Degrees, 7 with Master's Degrees, and 13 with Doctoral Degrees (MD, PhD or DVM).

In its forty years in Indonesia, NAMRU-2 made substantial contributions to local, global, and military medicine. The Navy laboratory trained Indonesian students, scientists, and public health workers in fundamental laboratory techniques, as well as virology, bacteriology, laboratory cultivation of malaria parasites, and sophisticated disease detection methods. It led a \$4 million effort to reduce annual cases of malaria in Central Java, donated a fully furnished research laboratory to LITBANGKES, developed an adult dengue vaccine site in West Java, stood up a field laboratory for the Sumatra tsunami relief effort, developed and deployed the computer-based Early Warning Outbreak Recognition System (EWORS), and trained the Ministry of Health to investigate dengue outbreaks in multiple provinces. In addition to these benefits to Indonesia, the Navy laboratory demonstrated the efficacy of both malarone and primaquine in preventing malaria, and, prior to January 2007, diagnosed more cases of avian influenza (H5N1) than any other laboratory worldwide.

In 2006, the Indonesian MoH began a protracted and still unsettled dispute with the international health community, particularly the World Health Organization (WHO), over material transfer agreements (MTAs), legal prerequisites to sharing viral specimens. Then–Minister of Health Siti Fadilah Supari asserted “viral sovereignty” over Indonesian H5N1 samples and demanded long-term, affordable access to vaccine stockpiles as a precondition for material transfer to any foreign or international organization. While Indonesia is not the only country to argue for a more equitable distribution of vaccines, or for greater transparency concerning the use of its viral isolate sequences, Jakarta's aggressive diplomacy in the midst of the avian influenza crisis and its restrictions on the sharing of viral specimens with WHO laboratories made the dispute a hotly contested and potentially precedent-setting test case.

NAMRU-2, as a WHO Collaborating Center for the Southeast Asia region, and the Centers for Disease Control and Prevention (CDC), whose headquarters in Atlanta served as a WHO International Influenza Reference Laboratory, followed WHO communication protocols and standard operating procedures. Both they and the U.S. Embassy became caught up in the dispute. The

renegotiation of NAMRU-2's Memorandum of Understanding (MOU) with Indonesia, already beset with significant bureaucratic delays on both sides since its expiration a decade earlier, became tied to the controversy. In 2008, Minister Supari targeted NAMRU-2 directly with unsubstantiated accusations of espionage, biological weapons research, and development of "new diseases" to enhance pharmaceutical companies' profit margins.

Larger political factors contributed to the overall breakdown in relations. Internal divisions in the Indonesian government complicated the negotiations, as did Indonesian dissatisfaction with the recent direction of U.S. foreign policy. In addition, with Indonesia in a more democratic phase of its history, many Indonesians have looked to distance the country from the legacy of former President Suharto, and some critics of NAMRU-2 painted the laboratory as an artifact of the Suharto era. This perception was compounded by the break in U.S.-Indonesian military-to-military relations that followed the Indonesian Army's crackdowns in East Timor in the early 1990s. In the face of escalating accusations and in the absence of a strong champion in the Indonesian government or military, NAMRU-2's presence in Jakarta became increasingly untenable. Negotiations over the new MOU broke down, and in June 2010, the U.S. Navy relocated the NAMRU-2 headquarters to Pearl Harbor, Hawaii.

Today, NAMRU-2 maintains a laboratory presence in Cambodia, with activities in Singapore, Vietnam, Laos, Thailand, and the Philippines. Under a new Minister of Health, Indonesian scientists have reached out to other U.S. military overseas laboratories, particularly USAMRU-K, for training and collaboration.

NAMRU-2's experience in Indonesia is not unprecedented and provides a sobering and instructional case study of sizable costs to U.S. military medical research, Indonesian disease detection and scientific capacity, and hundreds of local personnel who lost jobs. That experience stands in contrast to the more usual pattern in which the Army and Navy laboratories continue to draw broad support from host governments and local partners, and preserve their brand and legitimacy. As a rule, the laboratories respond quickly to erroneous accusations, cultivate and maintain champions in their host governments, and imbue their projects with a sense of local ownership. The unfortunate outcome in Indonesia reinforces the importance of these priorities.

APPENDIX E

TRAVEL AND INTERVIEWS

CSIS Team

LTG James B. Peake, MD (USA Ret.)

Kenya, Egypt, Thailand

Dr. J. Stephen Morrison

Peru, Kenya, Egypt

Dr. Katherine E. Bliss

Peru

Michèle M. Ledgerwood

Peru, Kenya, Egypt, Thailand, Cambodia

Seth E. Gannon

Peru, Kenya, Egypt, Thailand

NAMRU-6–PERU

August 23–25, 2010

Monday 23 August 2010–Lima

0830-1015	NAMRU-6 Command Brief CAPT John Sanders, LT Michael Gregory, LCDR Erik Reaves, LT Kirk Mundal, Dr. Andres Lescano, MAJ Eric Halsey, Mrs. Roxana Lescano, Dr. Silvia Montano
1030-1100	Peruvian Naval Hospital Rear Admiral Miguel Fernández Fajri
1115-1200	Universidad de San Marcos: Molecular Biology Laboratory Dr. César Gutiérrez Villafuerte, Dr. Paolo Wong, Dr. Julia Piscoya, Dr. Franco Romani, Dr. Romina Tejada, Dr. Verónica Palomares Absent: Dr. Jorge Alarcón, laboratory Head, who kindly sent comments via email
1230-1315	Peruvian National Institute of Health (Instituto Nacional de Salud) Dr. César Augusto Cabezas Sánchez

- 1600-1700 **Universidad Peruana Cayetano Heredia School of Public Health**
Institute of Studies in Health, Sexuality and Human Development (IESSDEH)
 Dr. Carlos F. Cáceres, Dr. Segundo León Sandoval
- 1800-1830 **ForoSalud (civil society health NGO)**
 Dr. Mario Rios Barrientos

Tuesday 24 August 2010—Lima

- 0800-0845 **Universidad Peruana Cayetano Heredia**
 Alexander von Humboldt Tropical Medicine Institute
 Dr. Eduardo Gotuzzo Herencia
- 0930-1130 **NAMRU-6 Laboratory Tour**
- 1230-1330 **General Epidemiology Directorate (Dirección General de Epidemiología)**
 Dr. Luis Suárez Ognio
- 1400-1500 **U.S. Embassy Lima—Chargé d’Affaires**
 Mr. Bruce Williamson
- 1500-1545 **U.S. Embassy Lima—Investing in People Working Group (IIPWG)**
 Dr. Erik G. Janowsky, Mr. Richard C. Merrin, Mr. Philip Kaplan
- 1545-1630 **U.S. Embassy Lima—Defense Attaché Office (DAO)**
 CAPT Joseph Piontek
- 1700-1745 **Pan American Health Organization (PAHO), World Health Organization (WHO)**
 Dr. Guillermo González

Wednesday 25 August 2010—Iquitos

- 1045-1200 **Tour of NAMRU-6 Iquitos Field Laboratory**
 Dr. Amy Morrison
- 1200-1400 **Community Clinical Visits and Mosquito/Larvae Collection**
- 1400-1600 **Working Lunch**
 CAPT John Sanders, Dr. Amy Morrison, Dr. Margaret Kosek,
 Mr. Pablo Peñataro Yori

Addendum: Friday 3 September 2010

1000-1030 **Centers for Disease Control and Prevention (CDC)—Lima (by phone)**
Dr. Joel Montgomery

USAMRU-K—KENYA

December 6–9, 2010

Monday 6 December 2010—Nairobi

0900-0930 **USAMRU-K Command Brief and Emerging Infectious Disease Brief**
COL Thomas M. Logan, LTC Eyako Kofi Wurapa, Mr. Berhane Assefa, LTC
Jamie Blow (WRAIR)

0930-1030 **Discussion and Tour, Viral Hemorrhagic Fever (VHF) Laboratory,**
Kenya Medical Research Institute (KEMRI)
Dr. Rosemary Sang

1100-1200 **Discussion and Tour, KEMRI National Influenza Center (NIC) Laboratory**
Dr. Wallace Bulimo

1400-1430 **Ministry of Public Health and Sanitation**
Department of Disease Prevention and Control
Dr. Willis Akhwale

1500-1530 **Executive Time – USAMRU-K**

1530-1700 **CDC**
Dr. Robert Breiman, Mr. Eric Gogstad, and CDC Global Disease Detection and
Response Center (GDDRC) staff

Tuesday 7 December 2010—Nairobi

0900-0930 **USAMRU-K: Military-to-Military (M2M) Brief**
President's Emergency Plan for AIDS Relief (PEPFAR) Brief
COL Thomas Logan and LTC Shon Remich

0950-1030 **Discussion and Tour, Armed Forces Memorial Hospital (AFMH)**
COL Daniel Mbinda, Hospital and Laboratory Staff

1030-1100 **Kenya Ministry of Defense**
Brigadier General Christopher Arrum

1130-1430	Tour and Community Health Visits: Carolina for Kibera (CFK) Dr. Robert Breiman, CDC, and CFK medical staff and community health workers
1500-1600	KEMRI Dr. Solomon S. R. Mpoke
1615-1630	U.S. Embassy Nairobi—DAO (by phone) COL David (Thor) McNevin

Wednesday 8 December 2010—Kisumu (Kondele, Kisian, Kombewa)

1030-1050	Overview: USAMRU-K Kisumu Field Station LTC(P) Maria Bovill
1050-1110	Tour, USAMRU-K Kondele Research Laboratory Dr. John Waitumbi
1110-1130	Tour, Obama Children's Hospital Wing and Ward 8 Dr. Bernhards Ogutu
1210-1230	Tour and Briefing, USAMRU-K Malaria Diagnostic Center (MDC) CPT(P) Jake Johnson
1230-1250	USAMRU-K Vector Biology Program Briefing CPT(P) Josh Bast
1410-1450	USAMRU-K Kisian Campus Tour of Vector Biology and Malaria Drug Resistance Laboratories
1520-1600	Kombewa Clinical Research Center (CRC) - Tour and Clinical Trials Program Brief LTC Louis Macareo and Agnes "Mama" Onyango
1600-1650	Discussion and Tour, Kisumu West District Hospital Dr. Nickson Shango, Dr. Walter Otieno

Thursday 9 December 2010—Kericho

0900-1300	Overview, Tour, and Discussion, USAMRU-K Kericho Field Station Dr. Douglas N. Shaffer, Dr. Fredrick K. Sawe, Professor Samuel Sinei, CPT Brett Swierczewski
1530-1700	Final Outbrief, Kisumu

NAMRU-3–EGYPT

December 11-13, 2010

Saturday 11 December 2010–Cairo

- 0830-1000 **NAMRU-3 Command Brief**
CAPT Robin Wilkening, CDR Young, Dr. Moustafa M. Mansour, LCDR David Rockabrand, Dr. R. Vincent Barthel, LCDR Peter Obenauer, Dr. Erica Dueger, Mr. Darnell P. Gardner, Jr., Mr. Michael T. Williams
- 1000-1130 **Tour of NAMRU-3**
- 1130-1300 **Working Lunch and Group Discussion**
CAPT Robin Wilkening, Department Heads

Sunday 12 December 2010–Cairo

- 0930-1100 **Ministry of Health**
Dr. Nasr E. Sayed
- 1330-1530 **U.S Embassy Cairo**
COL Kyle Carnahan, CDR Robert Copenhaver (DAO), Mr. Matthew Tueller (DCM)

Monday 13 December 2010–Cairo

- 1100-1200 **WHO, Regional Office for the Eastern Mediterranean**
Dr. Jaouad Mahjour
- 1300-1400 **USAID, Office of Health and Population**
Mrs. Holly Fluty Dempsey
- 1430-1530 **Cairo University Faculty of Medicine and Kas El Aini Hospitals**
Dr. Amani A. El Kholy, Dr. Sherif N. Amin, Dr. May Sherif,

AFRIMS–Thailand

January 4-7, 2011

Tuesday 4 January 2011–Bangkok

- 0800-0845 **AFRIMS Command Brief**
COL Robert A. Bowden, COL Arthur E. Brown

0845-0945	AFRIMS Department of Virology Brief and Group Discussion COL Robert Gibbons, LTC Stephen Thomas
1000-1030	Royal Thai Army (RTA) LTG Sahachart Pipithkul, RTA Medical Staff
1100-1300	Tour of AFRIMS Veterinary Medicine Building, Vivarium, and Insectary Department of Entomology and Department of Veterinary Medicine Briefs MAJ Sarah Hinds, MAJ Brian Evans
1330-1415	RTA MG Krisada Duangurai, LTG Suebpong Sangkharomya
1430-1515	Queen Sirikit National Institute of Child Health (QSNICH) Dr. Suchitra Nimmannitya
1530-1630	AFRIMS Department of Retrovirology Brief and Group Discussion Dr. Joseph Chiu, Dr. Mark de Souza
1830-2100	Dinner Hosted by the RTA GEN Choochat Kambhu-na-ayudhya, RTA Army Medical Leadership

Wednesday 5 January 2011—Bangkok

0730-0815	AFRIMS Facilities and Resource Management Briefs CPT Erin A. Adkins, MAJ John D. Belew, LTC John B. McNally
0900-0945	U.S. Embassy Bangkok—CDC Dr. Michael D. Malison, Dr. Sonja J. Olsen, Dr. Boonyos Raengsakulrach
0945-1015	U.S. Embassy Bangkok—Joint U.S. Military Advisory Group Thailand COL Edward A. Swanda, Jr.
1030-1100	U.S. Embassy Bangkok—DCM Mrs. Judith Cefkin
1245-1320	AFRIMS Safety and Occupational Health Brief LTC Mikal L. Stoner
1330-1400	Royal Thai Army MG Boonyarak Poonchai
1400-1500	AFRIMS Department of Immunology Brief and Group Discussion COL Douglas Walsh, MAJ David Saunders, MAJ Stuart Tyner
1515-1545	Mahidol Oxford Tropical Medicine Research Unit (MORU) Professor Nicholas P. J. Day

1600-1700 **AFRIMS Department of Enterics Brief and Group Discussion**
COL Carl Mason

Thursday 6 January 2011—Kamphaeng Phet

1000-1100 **Kamphaeng Phet AFRIMS Virology Research Unit (KAVRU) Brief and Discussion**
Dr. Darunee Tannitisupawong, COL Robert Bowden, COL Robert Gibbons

1100-1145 **Consulate General of the United States in Chiang Mai**
Ms. Susan Stevenson (visiting Kamphaeng Phet)

1145-1230 **Luncheon and Slide Show: Kamphaeng Phet Provincial Hospital (KPPPH)**
KPPPH and KAVRU leadership and staff

1230-1330 **KPPPH**
Dr. Kamchai Rungsimunpaiboon

1330-1500 **Visits to Clinical Research Center, Entomology site, Public Health Office, village, and elementary school**
Dr. Alongkot Ponlawat, Dr. Darunee, COL Bowden, COL Gibbons

Friday 7 January 2011—Bangkok

0730-0815 **AFRIMS Department of Epidemiology and Disease Surveillance Brief**
LTC Mitchell S. Meyers

0900-1000 **Ministry of Public Health**
Dr. Supachai Rerks-Ngarm, Dr. Prayura Kunasol

1100-1145 **Faculty of Tropical Medicine, Mahidol University**
Dr. Pratap Singhasivanon

1300-1345 **MORU**
Professor Nicholas J. White

1400-1500 **AFRIMS Wrap-Up and Informal Discussion**

1500-1530 **Royal Thai Army**
COL Sorachai Nitayaphan

Addendum: AFRIMS Malaria Team in Cambodia

Monday 10 January 2011

1900-2030 **Dinner: AFRIMS Department of Immunology**
MAJ David Saunders, MAJ Stuart Tyner, Chief, Laboratory Operations

Tuesday 11 January 2011

1400-1500 **Royal Cambodian Armed Forces (RCAF)**
MG Kong Saly, COL Satharath Prom, MAJ Deth Vantha (interpreter)

NAMRU-2 DETACHMENT—Cambodia

January 10-11, 2011

Monday 10 January 2011—Phnom Penh

0830-1000 **NAMRU-2 Detachment Brief**
CAPT William Rogers

1000-1100 **CDC**
Dr. Dora Warren

1100-1200 **National Institute of Public Health (NIPH)**
Dr. Ung Sam An, Dr. Saphonn Vonthanak

1330-1430 **Institut Pasteur in Cambodia (IPC)**
Dr. Vincent Deubel, Dr. Philippe Buchy

1500-1600 **National Center for Parasitology, Entomology and Malaria Control (NCMC)**
High Excellency Dr. Doung Socheat

Tuesday 11 January 2011—Phnom Penh

0830-0930 **Tour of the NAMRU-2 Detachment Laboratory**

1130-1200 **U.S. Embassy Phnom Penh—DAO**
COL Mark Gillette

1200-1230 **U.S. Embassy Phnom Penh—DCM**
Mr. Theodore Allegra

1530-1600 **U.S. Agency for International Development (USAID)**
Ms. Monique Mosolf



APPENDIX F

GLOSSARY—DISEASES OF MILITARY IMPORTANCE

The diseases listed below result from different forms of exposure and transmission. Some are vectorborne, acquired through the bite of a mosquito, flea, or tick; some are food- or waterborne, acquired by eating or drinking; some are respiratory, acquired through proximity to an infected person; and some result from contact with a contaminated medium or host, including water, soil, animals, and people.

The DoD overseas medical research laboratories have conducted research on all of these diseases, resulting in diagnostic capabilities, numerous vaccines, and multiple drugs for prevention and treatment.

African trypanosomiasis

A vectorborne disease caused by the parasitic protozoa *Trypanosoma*. Vector: bloodsucking Tsetse flies. Symptoms include malaise and irregular fevers and, in advanced cases in which the parasites invade the central nervous system, coma and death. Endemic in 36 countries of sub-Saharan Africa. Cattle and wild animals act as reservoir hosts for the parasites.

Brucellosis

A bacterial disease caused by the bacteria of the genus *Brucella*. Transmitted via contact with animals or contaminated animal products, particularly unpasteurized milk. Symptoms, which may become chronic, include fever, sweats, headaches, back pain, physical weakness and, in extreme cases, severe infections of the central nervous systems or lining of the heart.

Cholera

An acute diarrheal illness caused by the bacterium *Vibrio cholerae*. Transmission occurs through the consumption of food or water contaminated by feces from an infected person, or through the ingestion of raw shellfish from brackish rivers and coastal waters. Symptoms are severe in 5% of cases and include profuse watery diarrhea, vomiting, and leg cramps, with fluid loss leading to dehydration and shock.

Chikungunya

A vectorborne viral disease associated with urban environments. Vector: *Aedes aegypti* mosquito. Symptoms include sudden onset of fever, rash, and severe joint pain usually lasting 3-7 days. Some cases result in persistent arthritis.

Dengue and dengue hemorrhagic fever

A vectorborne viral disease associated with urban environments. Vector: *Aedes aegypti* mosquito. Symptoms include sudden onset of fever and severe headache. Occasionally produces shock and hemorrhage, with a death rate over 5%.

Enteric diseases

A class of infections that enter the body through the mouth and intestinal tract and result in severe diarrheal illness. Usually spread through contaminated food and water or by contact with vomit or feces.

Hepatitis

Hepatitis A: A contagious, viral liver disease. Acquired through consumption of food or water contaminated with fecal matter, principally in areas of poor sanitation. Symptoms include fever, jaundice, and diarrhea. 15% of victims will experience prolonged symptoms over 6-9 months.

Hepatitis B: A contagious, viral liver disease resulting from infection with the Hepatitis B virus (HBV). Transmitted through infected blood, semen, and other bodily fluids, primarily via unprotected sex and injection drug use. Also can be transmitted from mother to child at birth. Symptoms are mild but can develop into a serious, chronic, lifelong illness.

Hepatitis C: A contagious, viral liver disease. Transmitted through infected blood and acquired primarily via shared needles and other drug injection equipment. As with Hepatitis B, symptoms are mild but can develop into a serious chronic illness.

Hepatitis E: A waterborne, viral liver disease. Most commonly spread through fecal contamination of drinking water. Symptoms include jaundice, fatigue, abdominal pain, and dark-colored urine.

Human immunodeficiency virus/Acquired immune deficiency syndrome (HIV/AIDS)

HIV is an infectious viral disease transmitted primarily through unprotected sex, needle-sharing, and birth from an infected mother. HIV destroys specific blood cells that are crucial to the immune system. It can lead to AIDS, in which the body's compromised immune system makes it more susceptible to the development of infections and cancers. For this reason, co-infection with other diseases such as tuberculosis (TB) and Hepatitis C are of particular concern.

Influenza

Avian influenza ("bird flu"): An infectious viral disease of birds, including domesticated poultry. Some strains, such as the highly pathogenic H5N1, occasionally cause serious infections in humans. Most human cases of H5N1 result from direct or indirect contact with infected live or dead poultry. Initial symptoms, most notably a high fever, are similar to those of seasonal influenza; they also can include diarrhea, vomiting, abdominal pain, chest pain, and bleeding from the nose and gums. Later symptoms can include severe respiratory distress.

H1N1 pandemic influenza ("swine flu"): Now classified as post-pandemic, the 2009 pandemic H1N1 virus was an infectious viral disease spread from person to person. It originated from ani-

mal influenza viruses and resulted in unusual patterns of illness and death, most notably among young, healthy populations. Symptoms include malaise, fever, cough, headache, muscle and joint pain, sore throat, and runny nose. Some patients also experience vomiting and diarrhea and, in acute cases, viral pneumonia.

Japanese encephalitis (JE)

A vectorborne viral disease associated with rural areas in Asia, primarily rice fields. Vector: *Culex tritaeniorhynchus* mosquito. Mild cases have few symptoms; acute cases display high fever, neck stiffness, stupor, disorientation, and headaches, and can progress to paralysis or coma, with a fatality rate of 30%. Domestic pigs and wild birds act as reservoir hosts for Japanese encephalitis virus (JEV).

Leishmaniasis

A vectorborne disease caused by the parasitic protozoa *leishmania*. Vector: sandflies. Endemic in 88 countries. The cutaneous form affects the skin and, in the case of mucocutaneous leishmaniasis, the mucous membranes. Symptoms include skin lesions (open sores) that may become chronic. The visceral or systemic form affects the entire body. It is less common but potentially fatal. Symptoms include enduring fever (2-8 weeks), as well as fatigue, weight loss, and swelling of the spleen and liver. Children may experience additional symptoms including vomiting, diarrhea, fever, and cough.

Leptospirosis

A bacterial disease that affects both animals and humans. Infection occurs through contact with water, food, or soil contaminated by animal urine. Symptoms include high fever, severe headache, vomiting, jaundice, and diarrhea. If left untreated, it may result in kidney damage, liver failure, meningitis, or respiratory distress.

Malaria

A vectorborne disease caused by the single-cell parasitic protozoa *Plasmodium*. Vector: female *Anopheles* mosquito. Symptoms include fever, chills, headache, and sweats accompanied by anemia. Fatal when vital organs are damaged and blood supply to the brain is interrupted. Endemic in 100 countries, with 90% of cases occurring in sub-Saharan Africa. Of note, antimalarial drug resistance has begun to emerge, hampering global eradication efforts.

Meningococcal meningitis

A bacterial respiratory disease causing an inflammation of the lining of the brain and spinal cord. Transmitted from person to person. Symptoms include stiff neck, high fever, headaches, and vomiting. Death occurs in 5–15% of cases, typically within 24–48 hours of the onset of symptoms. The highest burden of meningococcal disease occurs in the hyperendemic region of sub-Saharan Africa known as the “Meningitis Belt,” which stretches from Senegal to Ethiopia.

Plague

A vectorborne bacterial disease caused by the organism *Yersinia pestis*. Manifests in three primary forms: bubonic (infection of the lymph nodes), pneumonic (lungs), and septicemic (blood). Vector: fleas, normally associated with rats; person-to-person airborne transmission of pneumonic plague is also possible. Symptoms of bubonic plague include sudden fever, headache, muscle pain, and painfully swollen lymph nodes. Pneumonic plague results in difficulty breathing, bloody sputum, and a severe cough; it is fatal if left untreated, and has a 50% death rate when treated. Septicemic plague, which often is fatal even before symptoms present, results in abdominal pain, bleeding, diarrhea, fever, vomiting, and organ failure.

Poliomyelitis (Polio)

A highly infectious viral disease that invades the nervous system. It is transmitted by person-to-person contact. While most people infected with polio have mild or no symptoms, 1% of polio cases result in permanent paralysis of the limbs, usually the legs. There is a 5–10% fatality rate among those paralyzed, resulting from paralysis of the respiratory muscles.

Rabies

A viral disease of mammals, affecting the central nervous system. Transmitted through saliva, usually from the bite of an infected animal, most commonly dogs, bats, and raccoons. Symptoms initially are non-specific fever and headache, progressing to anxiety, convulsions, and inflammation (swelling) of the brain. Fatal if left untreated, often from respiratory failure.

Rickettsial diseases

A class of vectorborne diseases carried primarily by ticks, but also by fleas and lice. It includes Lyme disease, tularemia, typhus, and several spotted fevers. Symptoms of tickborne diseases include fever, chills, muscle aches, fatigue, headache, and a distinctive rash that varies with each disease. In rare cases, paralysis occurs; it typically subsides once the tick is removed.

Rift Valley fever

A vectorborne viral disease primarily found in eastern and southern Africa, affecting domesticated animals and humans. Vectors: mosquitoes and other biting insects. Infection also may occur through the handling of infected meat or contact with blood. Symptoms are generally mild, but the disease may progress to hemorrhagic fever, encephalitis, or ocular disease, with a 1% fatality rate.

Schistosomiasis

A parasitic disease caused by the trematode flatworm *Schistosoma*. Transmitted through contact with contaminated water. Freshwater snails act as intermediate hosts and release a larval form of the parasite, which penetrates the skin. Humans then become the reservoir: worms mature and reproduce in the blood vessels, liver, kidneys, and intestines, releasing eggs that become trapped in tissues. Symptoms include fever, chills, lymph node enlargement, liver and spleen enlargement, abdominal pain, diarrhea, and frequent, painful, or bloody urination. Endemic in 74 developing countries, with 80% of cases in sub-Saharan Africa.

Tuberculosis (TB)

A bacterial disease spread from person to person, via coughing, sneezing, or speech. Symptoms include a persistent cough (possibly with blood), chest pain, fever, weakness, and weight loss. Potentially fatal if left untreated; also a major cause of death among people with AIDS. New drug-resistant strains of TB have emerged that are difficult to treat, including multi-drug resistant strains (MDR-TB) and extensively drug resistant strains (XDR-TB).

Scrub typhus

An acute, febrile, vectorborne disease, prevalent primarily in Japan and Southeast Asia. Vector: trombiculid mites (“chiggers”), found in areas of heavy scrub vegetation. Symptoms include fever, headache, muscle pain, cough, gastrointestinal symptoms, and a characteristic black scabbing at the bite locus; in extreme cases, symptoms can include hemorrhaging and intravascular coagulation.

Typhoid fever

A bacterial disease caused by the *Salmonella* serogroup *Typhi*. Acquired through contact with food or water contaminated by fecal matter. Symptoms include sustained high fevers, headache, constipation, and myalgia (muscle pain). When left untreated, death rates can reach 20%.

Yellow fever

A vectorborne viral disease found only in tropical South America and sub-Saharan Africa. Vector: mosquito. Symptoms range in severity from influenza-like symptoms to severe hepatitis and hemorrhagic fever. Fatality rate is less than 20%.

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World Health Organization. Fact Sheets: Infectious diseases. http://www.who.int/topics/infectious_diseases/factsheets/en/index.html

Centers for Disease Control and Prevention, National Center for Zoonotic, Vector-Borne, and Enteric Diseases. Fact Sheets. <http://www.cdc.gov/ncezid/>

Central Intelligence Agency. *The World Factbook*. Field Listing: Major infectious diseases. ISSN 1553-8133. <https://www.cia.gov/library/publications/the-world-factbook/fields/2193.html>



APPENDIX G

BIBLIOGRAPHY AND LINKS

The findings in this report derive predominantly from primary-source interviews with military medical researchers and their partners inside and outside government. The schedule of overseas interviews is detailed in the Travel appendix, and the contributions of U.S.-based experts are noted in the Acknowledgments.

Links to the websites of the DoD overseas medical research laboratories and their parent organizations, as well as a brief bibliography, are included below.

DoD Overseas Medical Research Laboratory Websites

Walter Reed Army Institute of Research (WRAIR)
<http://wrair-www.army.mil/>

Naval Medical Research Center (NMRC)
<http://www.med.navy.mil/sites/nmrc/Pages/index.htm>

Armed Forces Research Institute of Medical Sciences (AFRIMS)—Thailand
<http://afrims.org/>

Naval Medical Research Unit 2 (NAMRU-2)—Pacific
<http://www.med.navy.mil/sites/namru2pacific/Pages/default.aspx>

Naval Medical Research Unit 3 (NAMRU-3)—Egypt
<http://www.med.navy.mil/sites/namru3/Pages/namru3.aspx>

Naval Medical Research Unit 6 (NAMRU-6)—Peru
<http://www.med.navy.mil/sites/namru6/Pages/namru6.htm>

U.S. Army Medical Research Unit—Europe (USAMRU-E)—Germany
<http://www.usamru-e.hqusaureur.army.mil/>

U.S. Army Medical Research Unit—Kenya (USAMRU-K)—Kenya
<http://www.usamrukenya.org/>

Army Medicine
<http://www.armymedicine.army.mil/>

Navy Medicine
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ABOUT THE AUTHORS

The Honorable James B. Peake, MD, began his 38-year military career as an infantry officer in Vietnam following his graduation from the U.S. Military Academy at West Point. On his return, he attended Cornell University Medical College and went on to become board certified in general and cardiothoracic surgery and rise through positions of increasing clinical, administrative, and command responsibility, culminating his military career as the surgeon general, U.S. Army, and commander, U.S. Army Medical Command. He subsequently served as executive vice president and chief operating officer of Project HOPE, an international humanitarian organization, and as chief medical officer and chief operating officer of QTC Management, Inc., one of the nation's largest providers of outsourced medical examinations, prior to being nominated and confirmed as the sixth secretary of veterans affairs, where he served from 2007 to 2009. LTG Peake currently serves as senior vice president for CGI, a global provider of information technology services. He also has chaired two working groups for the Global Health Policy Center at CSIS.

J. Stephen Morrison, PhD, is director of the Global Health Policy Center and senior vice president at CSIS. With support from the Bill and Melinda Gates Foundation and other foundation and corporate contributors, CSIS seeks to advance a long-term strategic U.S. approach to global health, cultivate new global health champions, explore the security dimensions of global health, and link Washington-based work to emerging policy expertise in key developing and middle income countries. Beginning in the spring of 2009, Dr. Morrison directed the CSIS Commission on a Smart Global Health Policy, which published its final report, *A Healthier, Safer, and More Prosperous World*, in March 2010. Dr. Morrison writes widely, testifies often before Congress, has directed several high-level task forces, and is a frequent contributor in major media on U.S. foreign policy, global health, Africa, and foreign assistance. He served for seven years in the Clinton administration, four years as committee staff in the House of Representatives, and taught for twelve years as an adjunct professor at the Johns Hopkins School of Advanced International Studies. He holds a Ph.D. in political science from the University of Wisconsin and is a magna cum laude graduate of Yale College.

Michèle M. Ledgerwood is a consultant to the Global Health Policy Center at CSIS, with more than 20 years of experience in the U.S. and European defense and healthcare environments. Mrs. Ledgerwood has directed several multidisciplinary research programs and working groups, with a specific focus on biological terrorism preparedness, medical surveillance, emerging technologies, and trusted networks. For more than 12 years, she was the senior analyst for the U.S. Department of Defense's influential Highlands Forum. She is a long-time consultant to the CSIS Transnational Threats Project and was recently a strategic adviser to InSTEDD (Innovative Support to Emergencies, Diseases, and Disasters). Mrs. Ledgerwood has authored multiple publications on topics including global cyber threats, U.S. laboratory capacity, and complex humanitarian emergency response models. She has worked for both U.S. and European defense contractors and began her

postgraduate career at the Stanford University School of Medicine's Section on Medical Informatics. She holds degrees from Stanford and Harvard Universities and speaks six languages with varying degrees of proficiency.

Seth E. Gannon is a research assistant in the Global Health Policy Center at CSIS, where he has researched and written on pandemic influenza, the Obama administration's Global Health Initiative, public health in South Asia, and other topics. He has helped organize Fault Lines in Global Health, a series of debates on controversial health issues. In addition to his global health work, Mr. Gannon has led debate and public speaking clinics at CSIS and at high schools and colleges around the United States, and he has participated in public and radio debates on various public policy issues. He is a graduate of Wake Forest University.



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